Method of Test for
DETERMINING THE ASPHALT CONTENT OF ASPHALTIC MIXTURES BY THE IGNITION METHOD
DOTD Designation: TR 323M/323-02

I. Scope

A. This method of test determines the asphalt content of asphalt paving mixtures and pavement samples by removing the asphalt cement by ignition in a furnace. The asphalt content is expressed as percent by mass of moisture free mixtures.

B. Reference Documents
1. DOTD TR 108, Splitting and Quartering Samples
2. DOTD TR 307, Bitumen Content of Paving Mixtures by Reflux Extractor
3. DOTD TR 308, Bitumen Content of Paving Mixtures by Centrifuge
4. DOTD TR 309 (AASHTO T30), Mechanical Analysis of Extracted Aggregate
5. DOTD TR 319, Determination of the Moisture Content of Asphaltic Concrete (Loose Mix)
6. DOTD Materials Sampling Procedures: S101, Aggregates and Aggregates Mixtures; S201, Asphaltic Materials; and S203, Asphaltic Mixtures
7. ASTM D 4753, Specification for Evaluating, Selecting, and Specifying Balances for Use in Testing Soil, Rock and Related Construction Materials
8. Furnace manufacturer's instruction manual.

II. Apparatus

A. Balance – readable to 0.1g, and capable of measuring the mass of the test specimen, specimen trays and catch pan. The balance shall conform to the requirements of ASTM D 4753, Class GP2.

B. Specimen trays – of appropriate size that allows the test specimen to be thinly spread and allows air to flow up through and around the specimen particles. The test specimen shall be completely enclosed with screen mesh or perforated stainless steel plate or other suitable material.

Note 1: *Screen mesh or other suitable material with maximum and minimum opening of 2.35 mm (No. 8) and 600 microns (No. 30) respectively has been found to perform well.*

C. Catch pan – having sufficient size to hold the test specimen trays so that aggregate particles and melting asphalt binder falling through the screen mesh are caught.

D. Catch pan and specimen tray(s) handling apparatus – suitable for inserting catch pan and specimen tray(s) into furnace and removing hot catch pan and specimen tray(s) from furnace.

E. Miscellaneous hand tools – assorted spatulas, pans, bowls, and wire brushes for preparing hot mixtures and removing aggregate from specimen tray(s) and catch pan.

F. Protection gloves – well insulated and capable of withstanding 575°C (1075°F).

G. Eye protection

H. Oven – convection or forced draft, capable of maintaining a temperature of 175±5°C (350±9°F).

I. Furnace – having a temperature capability of 538°C (1000°F) and having an internal weighing system capable of measuring the mass of test specimen sizes of at least 3500g in addition to the mass of the specimen trays and catch pan. A data collection system shall also be included so that the specimen mass

loss can be automatically determined to the nearest 0.1 g and displayed during a test. The furnace shall turn off when the measured mass loss does not exceed 0.01 percent of the specimen mass for three consecutive one minute intervals. The equipment shall provide a printout of the test results. A filter capable of reducing furnace emissions shall also be incorporated in the furnace. The furnace shall be vented into a hood or to the outside and when set up properly will have no noticeable odors escaping into the laboratory. Furnace will have fan with capability to pull air through the furnace to expedite the test and to reduce escape of smoke into laboratory. The furnace shall be equipped so that the door cannot be opened during the ignition test. The furnace shall be supplied with a safety cage for cooling the specimen trays, specimens, etc.

J. Plant report – Ashpaltic Concrete Plant Report, Form No. 03-22-3085 (Figure 1).

K. Worksheet – Correction Factor for JMF (Figure 2).

III. Health Precautions

Proper precautions are to be taken whenever hot materials or equipment must be handled. Use container holder or thermal gloves while handling hot containers. Wear eye protection while stirring and weighing heated materials due to possible shattering of particles.

The use of high temperature gloves and eye protection is mandatory. The temperature of the furnace, test specimen, specimen trays and catch pan after removal from the furnace is extremely high. Therefore, caution must be exercised at all times when handling these items since failure to do so could result in serious injury, severe burns or fire. The test specimen, specimen trays and catch pan are to be place inside a safety cage to cool and are not to be placed near any combustible materials.

IV. Sample

A. Obtain samples of blended aggregate or each aggregate and recycled asphalt pavement (RAP) to be used in the JMF in accordance with DOTD S101.

B. Obtain samples of asphalt cement to be used in the JMF in accordance with DOTD S201.

C. Obtain samples of loose mix and pavement samples in accordance with DOTD S203.

D. Preparation of Test Specimens

1. Aggregate and Recycled Asphalt Pavement (RAP) Samples

   a. Place the samples in an oven and dry to a constant mass as defined by no weight loss in excess of 0.1% between successive weighings no less than 5 minutes apart.

   b. Reduce the aggregate sample by splitting in accordance with DOTD TR 108 and the RAP sample by quartering as described in Step D.2.c, after heating the sample until it can be handled and split efficiently, to obtain test specimens approximately the same size and gradation as that to be used for the mixture test specimen shown in Table 1.

   c. For RAP samples, determine the asphalt content of the RAP by averaging the results of three tests performed in accordance with Step V.B. for RAP samples, a correction factor of 0.6 is assumed for determining the asphalt content of the RAP. If there is doubt concerning the accuracy of the asphalt content or the correction factor of the RAP, determine the asphalt content of the RAP by a solvent extraction method (DOTD TR 307 or TR 308).

2. Loose Mix Samples
   a. If the mixture is not soft enough to separate with a spatula or trowel, place it in a large, flat pan and heat to 160 ± 5°C (320 ± 9°F) until a constant mass is achieved as defined by no weight loss in excess of 0.1% between successive weighings no less than 5 minutes apart. For quality control samples to be tested without prior conditioning, heat the sample only until it can be handled and split efficiently.
   b. Obtain a test specimen of the appropriate size as shown in Table 1.
   c. Reduce the sample by quartering in accordance with DOTD TR 108, Method B by placing the mixture on a nonabsorbent material.
3. Pavement Cores
   a. Warm the pavement sample in an oven to approximately 160±5°C (320±9°F).
   b. Carefully separate the sample in a large, flat pan while periodically returning the pan to the oven to facilitate separation of the aggregate particles and dry to constant mass as defined in Step IV.2.a.
4. Asphalt Cement (to be used in the JMF)
   Heat enough asphalt cement to mix three test specimens according to the Job Mix Formula (JMF) to 175 ±5°C (350±9°F).

V. Procedure

A. Correction Factor for JMF

Note 2: *The results of this test method may be affected by the type of aggregates and the aggregates mass loss due to heating at a high temperature as utilized in this procedure. Therefore, to optimize accuracy, establish a correction factor by testing two calibration specimens for each mix type. The calibration shall be performed on laboratory prepared specimens of asphalt mixture mixed in accordance with the percentages listed on the approved job mix formula (JMF).*

Additionally, the furnace shall be equipped with a data system to calculate a correction factor directly. This procedure is written to show the manual determination of the correction factor.

Note 3: *The following steps refer to the use of a "butter" mix. The "butter" mix prevents calibration specimen from being biased by residual asphalt mix retained in the mixing bowl. A mix based upon the percentages listed on the JMF is prepared using the same equipment to be used for making the calibration specimens. The mix is discarded. The equipment is not cleaned and the calibration specimens are mixed using the same equipment. The underlying assumption is that the residual materials left on the equipment after mixing will be constant.*

1. Prepare three calibration specimens at the JMF asphalt cement content and aggregate gradation. The approximate mass of the specimen shall be in accordance with Table 1. (The first calibration mix is considered the "butter" mix and shall be discarded.
2. Heat the aggregates, asphalt cement, mixing bowls and tools to approximately 175°C (350°F).
3. Remove and discard the "butter" mix from the bowl by scraping, leaving a uniform coating of asphalt mix residue.
4. Mix a calibration specimen using the heated aggregate and asphalt cement content conforming to the JMF.
5. Determine and record the mass of the specimen trays and catch pan

(W_p) to the nearest 0.1 g.

6. Evenly distribute approximately one-half of the specimen into each specimen tray.
7. Determine the mass of the specimen, specimen trays and catch pan (W_t) to the nearest 0.1g. Determine and record the initial mass of the specimen (W_s). (W_s) = (W_t) – (W_p).

Note 4: *Refer to the furnace manufacturer's operating manual for information on entering operating information and data into the furnace controls and data system.*

8. Set the furnace temperature to 500±5°C (950±8°F).
9. Enter the test specimen mass (W_s) into the furnace data system.
10. Place the specimen, specimen trays and catch pan into the furnace.
11. Heat the calibration specimen in the furnace at 500±5°C (950±8°F) until the change in mass of the specimen over a three minute interval does not exceed 0.01 percent of the specimen mass (W_s).
12. Measure and record the mass (W_l) of the specimen after ignition to the nearest 0.1 g. (This step is performed when the furnace data system does the calibration for the correction factor.)
13. Record the loss in mass of the calibration specimen in percent (C_s) from the furnace print out or calculate it (C_s) in accordance with Step VI.A and record.
14. Repeat steps 5 – 13 for the second calibration specimen.
15. Calculate the specimen correction factors (CF_1 and CF_2) in accordance with Step VI.2 and record.
16. Calculate the JMF correction factor in accordance with Step VI.B; however, if the difference between samples CF_1 and CF_2 exceeds 0.15 percent, repeat steps 1 – 13 and calculate CF_3 and CF_4. Discard the high and low results of all four specimens and use the average of the results as the correction factor (CF) for the job mix formula.

B. Asphalt Content of Mixture

Note 5: *The determination of asphalt content is affected by any moisture in the test specimen, because this moisture will be interpreted erroneously as asphalt cement. This procedure, therefore, requires the conditioning of the sample or specimen prior to testing or requires the determination of the moisture of the mixture in accordance with DOTD TR 319 which is then used in the calculation of the actual asphalt content.*

Additionally, the furnace may be equipped with a data system into which the operator enters a correction factor which is used by the data system to directly correct the asphalt content. This procedure is written to show the manual correction for the correction factor for the JMF.

1. Place the test specimen in the oven and dry to a constant mass (approximately two hours) at a temperature of 160±5°C (320±9°F) or determine the moisture content of specimen according to DOTD TR 319.
2. Set the furnace temperature to 500±5°C (950±8°F).

Note 6: *The test specimen can be placed in the furnace at significantly lower temperature since the furnace will quickly heat to the desired temperature once the specimen begins to burn. The furnace temperature is likely to increase during the ignition phase of the test.*

3. Determine and record the mass (M_p) of the specimen trays and catch pan to the nearest 0.1 g.

4. Into each of the specimen trays, evenly distribute approximately one-half of the specimen over the entire area of the tray.
5. Determine the mass (M_t) of the specimen, specimen trays, and catch pan to the nearest 0.1 g.
6. Calculate and record the initial mass (M_s) of the specimen. (M_s) = (M_t) – (M_p)
7. Enter the mass of the test specimen (M_s) into the furnace data system.
8. Place the test specimen, specimen tray(s), and catch pan into the furnace.
9. Heat the specimen in the furnace at the specified temperature until the change in mass of the specimen over a three minute interval does not exceed 0.01 percent of the specimen mass (M_B).
10. Allow the specimen and trays to cool, then determine and record the dry total mass of aggregate (M) of the specimen after ignition to the nearest 0.1 g. This is the mass that will be used for extracted aggregate gradation analysis.
11. Record the asphalt content.
    a. For conditioned test specimens, record the asphalt content from the furnace print out (AC_C) or calculate the corrected asphalt content (%AC) in accordance with Step VI.C.
    b. For unconditioned test specimens for quality control testing, record the asphalt content from the furnace print out or calculate the corrected asphalt content in accordance with Step VI.C.1. Determine the actual asphalt content by subtracting the moisture content of the mixture determined in accordance with Step V.C.2.

VI. Calculations

A. For specimen correction factor
   1. Calculate the percent specimen mass loss (C_S) to the nearest 0.01% using the following equation:

$$C_S = \frac{W_S - W_I}{W_S} \times 100$$

where:

W_I = total mass of the mixture calibration specimen after ignition, g
W_S = total mass of the mixture calibration specimen prior to ignition, g

example:

$W_I = 2236.6$
$W_S = 2372.1$

$$C_S = \frac{(2372.1 - 2236.6)}{2372.1} \times 100$$

$$= \frac{135.5}{2372.1} \times 100$$

$$= 0.057125 \times 100$$

$$= 5.7125$$

$$C_S = 5.71\%$$

   2. Calculate the specimen correction factor (CF_n) to the nearest 0.01% using the following equation:

$$CF_n - C_S - AC_t$$

where:

C_S = percent specimen mass loss
AC_t = percentage of asphalt cement in the mix by mass of the total mix for the JMF.

example:

$C_S = 5.71$
$AC_t = 5.2$

$$CF_n = 5.71 - 5.2$$
$$CF = 0.51$$

B. For correction factor for the JMF Calculate the correction factor (CF) for the JMF to the nearest 0.01% using the following formula:

$$CF_a = \frac{CF_1 + CF_2}{2}$$

where:

CF_1, CF_2 = the measured mass loss (percent) of calibration specimen number 1 and number 2, respectively, by mass of total mixture
2 = number of specimens

example:

$CF_1 = 0.51$
$CF_2 = 0.53$

$$CF_a = \frac{0.51 + 0.53}{2}$$

$$= \frac{1.04}{2}$$

$$CF_a = 0.52$$

C. Calculate the percent actual asphalt content
1. For conditioned specimens, calculate the percent actual asphalt content (%AC) of the conditioned specimen to the nearest 0.1% using the following formula:

$$\%AC = (\frac{M_L}{M_S} \times 100) - CF$$

or

%AC = value from furnace print out

where:

CF_1, CF_2 = the measured mass loss
M_L = total mass after ignition, g
M_S = total mass of the test specimen prior to ignition, g
CF = correction factor obtained in Step VI.B

example:

$M_L = 126.8$
$M_S = 2248.3$

$$\%AC = (\frac{126.8}{2248.3} \times 100) - 0.52$$

$$= (0.0563 \times 100) - 0.52$$

$$= 5.63 - 0.52$$
$$= 5.11$$
$$\%AC = 5.1\%$$

2. For unconditioned samples, calculate the percent asphalt content ($\%AC_m$) of the test specimen use the following formula:

$$\%AC = \%AC - \%MC$$

where:

%AC = asphalt content prior to correction from the furnace print out or calculated in Step VI.C
%MC = moisture content determined in accordance with DOTD TR 319

example:

%AC = 5.6
%MC = 0.5

$$\%AC_m = 5.6 - 0.5$$
$$\%AC_m = 5.1\%$$

VII. Report

Report the following:

A. Date
B. Identification of plant, mix type and JMF
C. JMF sequence number and sample number
D. Correction factor for JMF (nearest 0.01%)
E. % Moisture of mixture when needed (nearest 0.1%)
F. Mass of specimen before ignition (nearest 0.1 g)
G. % Asphalt content of mixture (nearest 0.1%)
H. Mass of aggregate after ignition (nearest 0.1%)

VIII. Normal Test Reporting Time

The normal test reporting time is as follows:

Test specimens - 3 hours
Establishing correction factors – 1 day

Table 1
Size of Test Specimen

Nominal Maximum Aggregate Size, mm	Nominal Maximum Aggregate Size, U.S. Standard	Minimum Mass of Test Specimen, kg
4.75	No. 4	0.5
9.5	3/8 in.	1
12.5	½ in.	1.5
19.0	3/4 in.	2
25.0	1 in.	3
37.5	1½ in.	3.5

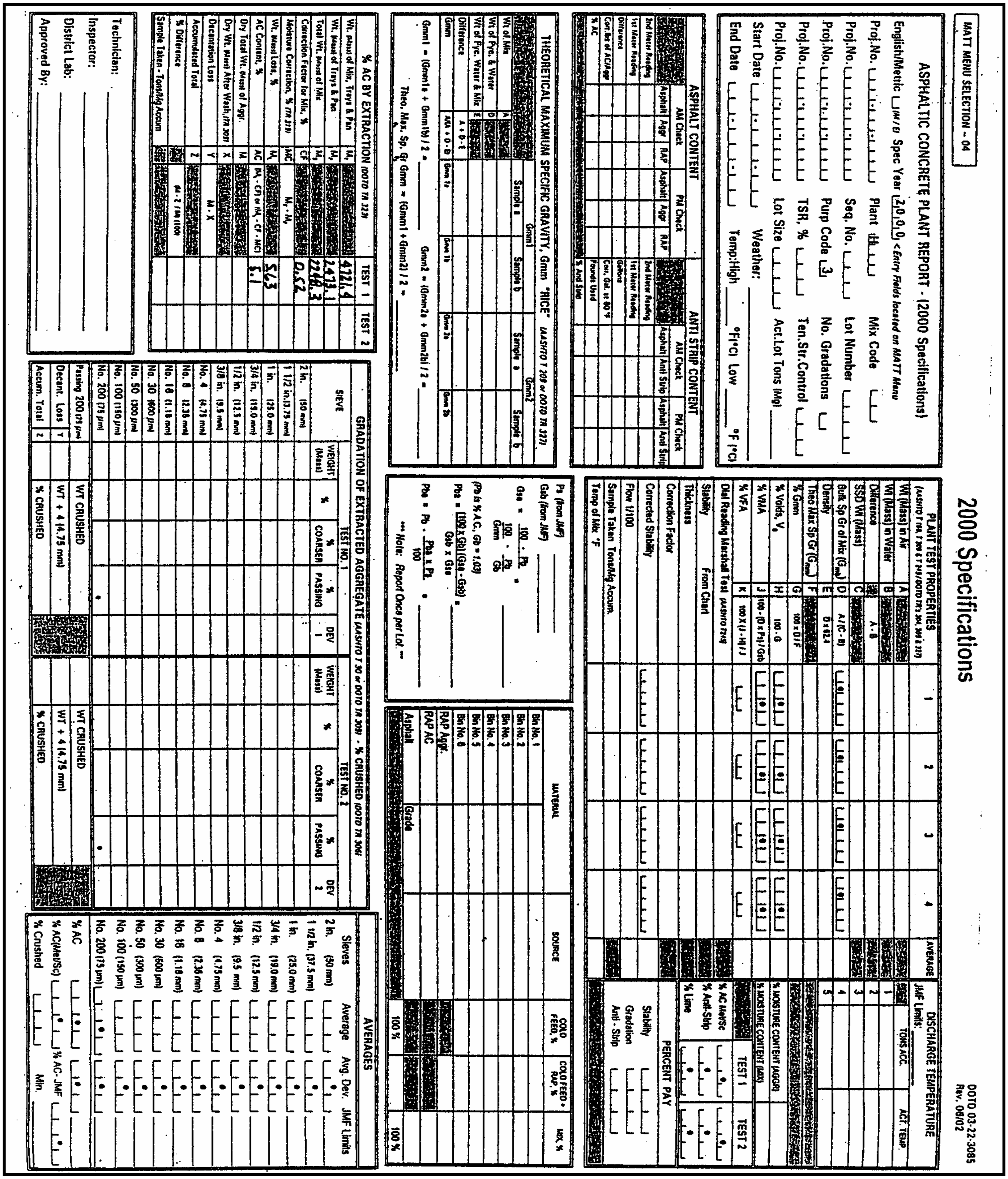

Figure 1
Asphaltic Concrete Plant Report (03-22-3085)

MATT MENU SELECTION - 09

DOTD 03-22-0737 (9/97)
METRIC

Louisiana Department of Transportation and Development
Materials and Testing Section
CORRECTION FACTOR FOR JMF
(DOTD TR 323)

Project No. ___-___-____ Date Rec'd. _____
Material Code 641 Lab No. ____-____-____
Date Sampled __-__-__ Submitted By ____
Quantity _____ Units Mg Purpose Code __
Plant Code H___ Spec. Code __
P O No. _____ Date Tested __-__-__
Ident. _____
Remarks 1 _____
Remarks 2 _____
Item No. ___(___)(__)

PURPOSE CODES
1. Quality Control
2. Verification
3. Acceptance
4. Check
5. Resample
6. Source Approval
7. Design
8. Independent Assurance
9. Preliminary Source Test

Sampled By: _____ Date: _____

	TEST RESULTS	P/F
	XXXXXXXXXXXXXXXXXX	XXX
PLANT NAME		XXX
JOB MIX FORMULA SEQUENCE NO.		XXX
	XXXXXXXXXXXXXXXXXX	XXX
MIX CODE		XXX
CORRECTION FACTOR FOR JMF	.•	XXX

Mix Correction Factor (DOTD TR 323)			Test 1	Test 2	Test 3	Test 4
Mass of Mix, Trays & Pan	W_t		4845.5	4861.8		
Mass of Trays & Pan	W_p		2473.4	2472.9		
Total Mass of Mix	W_s	$W_t - W_p$	2372.1	2388.9		
Mass of Mix After Ignition	W_l		2236.6	2252.0		
Percent Mass Loss	C_s	$\frac{W_s - W_l}{W_s} \times 100$	5.71	5.73		
Total AC From JMF, %	AC_t		5.2	5.2		
Correction Factor	CF_n	$C_s - AC_t$	0.51	0.53		

$CF_1 - CF_2 =$ _____ (Not to exceed 0.15%)

Correction Factor For JMF (CF) $CF = \frac{CF_1 + CF_2}{2} =$

Tested by: _____ Date: _____ Checked by: _____ Date: _____

APPROVED BY: _____ Date: _____ (OVER)

Figure 2
Correction Factor for JMF (03-22-0737)